

Exhibit 6

PLAINTIFFS' OPPOSITION TO DEFENDANTS' MOTION TO EXCLUDE PLAINTIFFS' EXPERTS' GENERAL CAUSATION OPINIONS FOR FAILURE TO ACCOUNT FOR SECTION 230 AND THE FIRST AMENDMENT

Case No.: 4:22-md-03047-YGR

MDL No. 3047

In Re: Social Media Adolescent Addiction/Personal Injury Products Liability Litigation

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**SUPERIOR COURT OF THE STATE OF CALIFORNIA
COUNTY OF LOS ANGELES, CENTRAL DISTRICT**

**COORDINATION PROCEEDING SPECIAL
TITLE [RULE 3.400]**

SOCIAL MEDIA CASES

THIS DOCUMENT RELATES TO:

ALL ACTIONS

*(Christina Arlington Smith, et al., v. TikTok
Inc., et al., Case No. 22STCV21355)*

**JUDICIAL COUNCIL COORDINATION
PROCEEDING NO. 5255**

**EXPERT REPORT OF DR. RANDY
AUERBACH**

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CONFIDENTIAL – SUBJECT TO PROTECTIVE ORDER**I. Introduction and Qualifications**

1. My name is Randy P. Auerbach, PhD, ABPP. I am a tenured Professor in the Department of Psychiatry at Columbia University where I serve as Co-Director of the Center for the Prevention and Treatment of Depression. I received my B.A. from Cornell University (2000) and Ph.D. in Clinical Psychology from McGill University (2010). As part of my graduate training, I completed my internship at Harvard Medical School-McLean Hospital. I also am a board-certified licensed clinical psychologist.

2. My research is committed to improving our understanding of depression and suicide in adolescents. My work is multidisciplinary and utilizes a multimodal approach for assessment (e.g., laboratory-based experiments, passive sensor monitoring, social media, electrophysiology, and neuroimaging) to determine why depressive symptoms unfold, how self-injurious and suicidal behaviors develop, and what changes in the brain during treatment. As a whole, my research aims to better understand mechanisms that may improve early identification of and treatment for adolescent depression and suicidal behaviors. My work is funded by grants from the National Institute of Mental Health, the Klingenstein Third Generation Foundation, the Dana Foundation: Clinical Neuroscience Research Grant, and several private foundations, with current grant funding including projects that probe objective use of smartphone and social media use to understand the impact, if any, on brain functioning, depression, and suicide risk among adolescents.

3. My research has led to over 220 published, peer-reviewed scientific papers and book chapters. This work is highly cited (H-index = 75; citations as of April 11, 2025, n = 23,323), reflecting a significant scientific impact in the field. In light of my recognition as a scientific leader, I am a frequent speaker at grand rounds for leading academic institutions (e.g., Stanford University, Harvard Medical School, Cornell University), an invited keynote speaker at national and international conferences (e.g., International Summit on Suicide Research, China International Conference on Suicidology), and a presenter on expert panels at leading mental health organizations (e.g., National Institute of Mental Health, American Foundation for Suicide

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Prevention)—all venues to share recent innovations and scientific advancements of my clinical research.

4. Given the scientific and clinical impact of my work, I have been the recipient of many prestigious awards. For example, as an early career investigator, I received awards from the American Psychological Association, including the David Shakow Early Career Award for Distinguished Scientific Contributions in Clinical Psychology and the Richard Abidin Early Career Award. Additionally, from the American Psychological Foundation, I was the recipient of the Theodore Blau Early Career Award. These awards were given in recognition that my research had a “major impact on the field” of depression and suicide. More recently, I received the Joel Elkes Research Award from the American College of Neuropsychopharmacology (ACNP). ACNP is a member-only scientific organization (i.e., admitted through a rigorous evaluation process based on contributions to the field of psychology and psychiatry), and the Joel Elkes Research Award is given annually to a researcher who has made “outstanding” clinical research advancements in the field. Prior winners of this award include directors of NIH institutes (e.g., Nora D. Volkow, MD) as well as department chairs at leading psychiatric institutes (e.g., Scott L. Rauch, MD).

5. A copy of my CV is attached as Exhibit A. During the previous four years, I have not testified as an expert at trial or by deposition.

6. I have been asked by counsel for Defendants in the above-captioned litigation to apply my professional experience and expertise to consider certain claims in this litigation regarding the relationship between social media use and adolescent mental health harms. I have no prior relationship with any Defendant or, to my knowledge, any other party.

7. I have applied the same scientific rigor to this matter, as I apply to my own research endeavors. I hold my opinions presented in this report to a reasonable degree of medical and scientific certainty.

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8. I am being compensated for my time at an hourly rate of \$1,000, plus expenses. My compensation is not conditioned or contingent on the opinions I reach or the outcome of this litigation.

9. Consistent with the standards that I follow in my research and publications, this report is based on my education, knowledge, experience, and expertise in psychology, as well as my review of relevant peer-reviewed publications. A list of the publications and other materials I have considered in connection with this matter is attached as Exhibit B.

II. Summary of Opinions

10. In this expert report I address the Plaintiffs' claims that: (i) social media use operates like an addictive substance that negatively affects adolescent brain development, (ii) social media causes mental health disorders in youth, and (iii) specific social media features cause adolescent mental health disorders.

11. *First*, there is no clinically recognized definition of social media addiction, and it is not recognized as a disorder in the DSM-5. The tools (e.g., Bergen Facebook Addiction Scale [Andreassen et al., 2012], Bergen Social Media Addiction Scale [Andreassen et al., 2017]) that have been used to identify “social media addiction” in adolescents are based on a theoretical model—the “components” model of addiction (Griffiths, 2005)—which was developed to quantify factors related to addiction in the context of substance use (e.g., nicotine, alcohol, drugs). This model is not appropriate for assessing purported “addiction” to social media, as it wrongly pathologizes frequency of use. This is problematic because adolescence is characterized by a natural and healthy increased drive to socialize, and social media is often the forum through which this socialization occurs. A substantial body of research focused on behavioral addiction (versus addiction related to substances) has demonstrated that measurements of “frequency of use” do not properly distinguish between pathological and non-pathological behaviors (Calvo et al., 2018; Charlton et al., 2007; Flayelle et al., 2019) and therefore cannot be a basis for clinically significant conclusions.

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12. *Second*, the existing scientific literature does not support a claim that social media use causes disruptions in adolescent brain development. Most of this research measures brain activations in amounts or contexts that are not clinically problematic or concerning, and the research as a whole shows no consistent statistically significant associations. The studies that do report statistical associations are generally deeply problematic and unreliable, as they are plagued by: (a) small sample sizes; (b) failure to account for known confounders (e.g., early life adversity or academic stressors); (c) reliance on cross-sectional designs that cannot establish temporality, let alone causation; (d) poor assessments of social media use (e.g., no use of objective assessments, not uncoupling content versus features); and (e) failure to account for other underlying psychiatric diagnoses (which may be affecting brain activity). These issues, whether singularly occurring or in combination, substantially undermine the reliability and validity of this research.

13. *Third*, the existing scientific research does not demonstrate that social media use causes negative adolescent mental health outcomes, let alone the clinical mental health disorders Plaintiffs allege. In fact, the research is inconsistent with that claim. If there were a causal relationship, one would expect to see strong, significant, and consistent associations across research studies. This would be a necessary, even if not sufficient, prerequisite to any causal conclusion. This is not what this area of research shows. Moreover, the studies that do find statistically significant associations are plagued by substantial methodological limitations, such as: (a) reliance on cross-sectional designs that cannot establish temporality, let alone causation; (b) unreliable and non-representative assessments of social media use (e.g., single item measures assessing screen time); (c) not accounting for offline experiences that otherwise better explain the emergence of psychiatric disorders (e.g., family or academic stressors); (d) not accounting for known confounders that are more likely to affect the occurrence of psychiatric disorders (e.g., prior psychiatric disorders); (e) using experimental designs that do not mask desired outcomes (and therefore forecast desired responses/outcomes from participants); (f) reliance on study samples that are not representative of adolescents within the United States; and (g) failure to test whether social media use leads to the onset of mental health disorders as opposed to potential changes in

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symptoms or mood fluctuations. Furthermore, those statistically significant associations that have been reported are weak and indicate that other factors explain the outcomes being measured.

14. *Last*, research investigating possible links between specific social media features and adolescent mental health also has failed to establish causation. Again, there are serious limitations to the existing research, diminishing the strength of any statistically significant associations reported, including: (a) use of non-representative samples (e.g., first year college students); (b) over-reliance on cross-sectional designs that cannot establish temporality, let alone causation; (c) use of unreliable self-report assessments to assess how participants engage features (versus objective use of features in native social media platforms); (d) failure to account for confounders that are more directly related to adolescent mental health outcomes (e.g., current/past psychiatric symptoms and disorders); and (e) failure to test any relationship to the onset of mental health disorders, as opposed to potential changes in symptoms or mood fluctuations. Moreover, the current research is not generalizable, as features are tested without considering content or context offered on social media platforms. There is a wide array of functions within and across social media platforms (e.g., videos, news, direct messages), and the experimental designs that attempt to isolate single features are not representative of how youth engage with social media platforms.

15. In sum, based on my expertise, clinical research experience, and review of peer-reviewed literature, it is my opinion that reliable, scientific evidence does not support Plaintiffs' claims that use of social media causes purported "social media addiction," negative brain changes, or mental health disorders in adolescents.

III. Development in Adolescence

16. Adolescence is a key phase of human development that prepares young people to be independent and autonomous. It is a period of social learning, found among all social species, where a young person develops their own identity and learns more deeply how to relate to other people and navigate social structures (Erikson, 1968; Tanti et al., 2011). Adolescence is characterized by enormous neural, pubertal, social, and psychological changes (e.g., Nelson et al.,

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2005; Romer & Walker, 2006) and typified by an ongoing tension between childhood and adulthood. These developments in adolescents' identities give rise to internal and external challenges—often described as a period of *storm and stress*—which for some, results in wide-ranging mood disruptions, conflicts with guardians, and engagement in risky behaviors (Arnett, 1999). These challenges can arise in both offline and online settings. Although these challenges can be difficult to deal with in the moment, they are a normal and healthy part of adolescent development and core to the “coming of age” process.

A. Neural Development

17. Adolescence is a critical period of neurobiological growth, as the brain undergoes structural and functional changes in gray and white matter (Sowell et al, 1999, 2003). Neuroimaging studies have highlighted key developmental differences in brain development during this time. Subcortical and limbic regions such as the amygdala and striatum—areas of the brain that are critical to emotional arousal and learning—mature more quickly than prefrontal regions of the brain—areas of the brain that are directly implicated in control, planning, and problem solving. This leads to a natural impulse among adolescents to learn and seek out new experiences, particularly social experiences (e.g., form peer and romantic relationships). This pursuit of social relationships engages reward-related brain activity (e.g., striatum) and the dopamine system (Kumar et al., 2019; Pagliaccio et al., 2023).

18. The differential brain development within the limbic and prefrontal regions, and the behavioral changes that accompany this, serve an important developmental function. Models of both animals (e.g., Spear, 2000) and humans (e.g., Casey et al., 2008, 2011; Ernst et al., 2006) suggest that adolescence is a critical transitional period where people grow and learn precisely because they are less inhibited. Adolescents typically exhibit a tendency to act without the full consideration of long-term consequences. Over time, as the prefrontal cortex develops, it helps with tempering adolescents' impulsiveness (Hare, 2008). At the same time, these reduced inhibitions during childhood and adolescence are essential for helping youth push beyond their own natural boundaries of discovery, allowing them to identify new passions and future goals.

CONFIDENTIAL – SUBJECT TO PROTECTIVE ORDER**B. Social Changes**

19. Adolescence is a period of substantial social upheaval. Indeed, as discussed above, social learning is perhaps the core function of adolescence. Adolescents exhibit greater reliance on peer support (e.g., Collins & Steinberg, 2006; Tanti et al., 2011; Wray-Lake et al., 2016), as they pursue romantic relationships and social status (Collins & Steinberg, 2006) and cultivate enhanced autonomy, particularly from parents (Daddis, 2011). It is not uncommon for shifts in social relationships to result in interpersonal stress (i.e., relational stress), especially as adolescents learn to navigate challenging social complexities and nuances (e.g., Eberhart & Hammen, 2009; Troop-Gordon et al., 2017). Evidence shows that older adolescents, relative to younger adolescents (i.e., high school versus middle school aged youth), experience more stressors, especially in domains related to family, friends, and school. Notable sex differences also appear, with older girls, relative to boys, reporting a higher number of friend-related stressful events (Larson & Ham, 1993).

20. Several theoretical models account for the role of interpersonal stressors in the occurrence of psychiatric symptoms and disorders. For example, Hammen (1991) introduced the concept of “stress generation,” which posits that the stress arises both from individuals’ own characteristics and their environments. Initial research among adolescents (e.g., Hammen & Brennan, 2001; Patton et al., 2003) focusing on stress generation showed that individuals with a history of major depressive disorder were more likely to experience greater relational or interpersonal stressors over time, which then conferred increased risk for subsequent depressive episodes over time. Research also demonstrated that a wide range of risk factors (e.g., parental psychiatric disorders, early adversity, low self-esteem) may lead to interpersonal stress exposures, which over time may then lead to the occurrence of psychiatric disorders (e.g., Hankin, Kassel & Abela, 2005; Joiner et al., 2005; Caldwell et al., 2004). Other research has shown that individuals who develop depression may become more sensitive to stressors, such that less severe life stressors can trigger future depression (Monroe & Harkness, 2005; Rudolph & Flynn, 2007).

21. At the same time, navigation of these formative experiences with social stress is a critical piece of adolescent development. Indeed, an individual’s ability to thrive as a healthy adult

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is often a direct consequence of having experienced and learned to effectively tolerate, manage, and overcome stress during adolescence.

* * *

22. Adolescence is a period of substantial developmental upheaval with a wide range of expected and normal changes that have enormous short- and long-term benefits. These include the pursuit of independence and autonomy, pubertal growth that often stimulates independence, the exploration of romantic relationships and sexual identities, and neural changes that favor impulsive over planned actions. From time immemorial, the timing, course, and context of these changes have meant that adolescence is a typical period for the onset of psychiatric disorders. This is particularly true when these factors are joined with other known vulnerabilities (e.g., certain parenting styles, learning disabilities, bullying, earlier pubertal onset, economic disadvantage, reduced access to clinical care). Notwithstanding, opportunities for learning, self-expression, and social interaction provide adolescents critical tools for healthy development. As discussed further below, social media platforms are one way in which adolescents capitalize on these opportunities to further their individual and interpersonal development through fostering social connectedness and support.

IV. Plaintiffs’ Claim That Social Media Use Causes Negative Mental Health Outcomes for Teens Is Not Supported By Reliable Evidence or Methods

23. Plaintiffs claim that Defendants’ platforms cause “social media addiction”; that social media use disrupts adolescent brain development; and that social media use causes mental health disorders (e.g., depression, anxiety, and suicidal thoughts and behaviors). None of these claims is supported by the published scientific research. Moreover, consensus reports from experts in the field reject these conclusions (e.g., American Psychological Association in a published *Health Advisory on Social Media Use in Adolescence* [APA, 2023], National Academies of Sciences, Engineering, and Medicine in a consensus report focused on social media and adolescent mental health [National Academies of Sciences, Engineering, and Medicine, 2024]).

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24. As a clinical research scientist devoted to the study of adolescent mental health with a particular focus on technology and neurobiology, I am deeply familiar with the most significant trends and findings in the scientific literature relating to adolescent mental health and social media. I regularly review literature in this area and integrate it into my clinical practice.

25. In preparing my opinions in this case, I drew on that experience but also conducted a specific literature review to make sure I was capturing the state of the science. Accordingly, I reviewed the sources collected by major scientific organizations in their reports on this field of research, namely the National Academies of Sciences, Engineering, and Medicine consensus study report, *Assessment of the Impact of Social Media on the Health and Wellbeing of Adolescents and Children*, the American Psychological Association *Health Advisory on Social Media Use in Adolescence*, and Dr. Mitch Prinstein’s written testimony on behalf of that same organization before the U.S. Senate Committee on Judiciary. I also conducted searches on PubMed and Google Scholar, searching for articles within reputable peer-reviewed English language journals that address (or purport to address) the question of whether social media use causes the specific mental health disorders at issue. This is consistent with how I would approach this literature if I was preparing a scientific article for a peer reviewed publication. Finally, to confirm that I reviewed the studies that Plaintiffs are relying upon, I reviewed the citations from the master complaint to evaluate the research that they believe most strongly supports their case.

26. A list of all of the studies I considered in forming my opinions is attached as Exhibit B. I do not discuss each of those studies in this report. Rather, in the sections that follow, I discuss exemplar studies that illustrate the key analytical points and themes I developed based on my broader review. I reserve the right to supplement this report and/or respond to specific points raised in Plaintiffs’ experts’ reports.

A. Scientific Literature Does Not Support A Causal Link Between Social Media Use and “Addiction” or Adolescent Brain Changes

27. Plaintiffs claim that social media platforms are designed to be “addictive” and cause adolescent users to engage in “compulsive use.” Plaintiffs further claim that adolescents are

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uniquely susceptible to harm from Defendants’ apps “because their prefrontal cortex is not fully developed.” Master Complaint ¶64. Plaintiffs also claim that Defendants’ apps manipulate the release of dopamine in young brains and that this “interferes with the brain’s development and can have long-term impacts on an individual’s memory, affective processing, reasoning, planning, attention, inhibitory control, and risk-reward calibration.” *Id.* ¶76. Plaintiffs claim that “children find it particularly difficult to exercise the self-control required to regulate their use of Defendants’ platforms, given the stimuli and rewards embedded in those apps, and as a foreseeable consequence tend to engage in addictive and compulsive use.” *Id.* ¶79.

28. Plaintiffs further allege that social media use can cause various mental health disorders in adolescents including anxiety, depression, eating disorders, self-harm, and suicide. Plaintiffs’ argument has two prongs: (1) social media platforms cause “addiction” and (2) this “addiction” causes various mental health disorders. A key part of this argument is Plaintiffs’ claim that “addictive use” of social media causes negative changes in adolescent brain development.

29. In this section, I first address Plaintiffs’ claims regarding “social media addiction” and “compulsive use.” I then turn to Plaintiffs’ claims that social media use can cause negative impacts to adolescent brain development. In short, based on my experience and review of the relevant literature, I conclude that none of these claims has a reliable scientific basis.

1. There is no universally accepted, recognized, or validated psychiatric disorder involving social media addiction.

30. At present, social media addiction is not recognized as a psychiatric disorder. There are no universally agreed upon criteria for assessing addiction to social media, and it is not a psychiatric disorder that appears in the DSM-5. The DSM-5 is the diagnostic manual of recognized mental disorders published by the American Psychiatric Association, which provides a standardized means of classifying and diagnosing all psychiatric disorders. Specifically, it details the diagnostic criteria (i.e., symptoms) for all recognized psychiatric disorders and provides a common language for patients, clinicians, researchers, and the public sector.

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31. Most research that has explored the idea of social media addiction has relied on self-report measures (e.g., Bergen Facebook Addiction Scale [Andreassen et al., 2012], Bergen Social Media Addiction Scale [Andreassen et al., 2017]), which have not established specific cut-offs that are validated as reliable scores indicative of an addiction. For example, the Bergen Social Media Addiction Scale is a 6-item self-report measure that rates items on a scale from 1 (*very rarely*) to 5 (*very often*). The items assessed are based on Griffiths’ “components” model of addiction. They are: (a) salience (i.e., importance of activity), (b) tolerance (i.e., increased time/effort to achieve same effect), (c) mood modification (i.e., use to change/enhance mood), (d) relapse (i.e., loss of control), (e) withdrawal symptoms, and (f) conflict (i.e., problems with friends/family regarding use) (Griffiths, 2005). Problematically, among researchers who have used this scale, there is no universally accepted cutoff score to establish the presence of purported social media addiction (see Bányaí et al., 2017 [cutoff score = 19] versus Luo et al., 2021 [cutoff score = 24]) as examples of studies using different cutoff scores).

32. Although Griffiths’ components model of addiction may be well-suited to characterize alcohol, tobacco, and drug use disorders, recent research has shown that it may prove problematic when focusing on potential behavioral addictions (i.e., situations wherein there is not an addictive substance). In the context of evaluating certain behaviors as addictive or not, there is a tendency to pathologize peripheral behaviors (e.g., frequency of use). Specifically, research focusing on behavioral addiction has often relied on what is known as a “confirmatory approach,” whereby greater engagement in appetitive behaviors (i.e., experiences and activities one enjoys) is *a priori* operationalized as an addictive disorder (Billieux et al., 2015; Flayelle et al., 2022). Measures, such as the Bergen Social Media Addiction Scale, are then constructed around the premise that “more use is problematic,” which has led to over-pathologizing a wide range of behaviors (e.g., Kardefelt-Winther et al., 2017; Satchell et al., 2021).

33. This fundamental flaw is similarly problematic and misleading in the context of social media use. Most of this research has focused on “time spent on social media” as an indicator of purported addiction (e.g., Fournier et al., 2023), but time spent may simply reflect the adolescent

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drive to use technology to socialize with peers, which is developmentally normative and appropriate. Social media is a forum for diverse social interactions. Therefore, frequency of use is a poor indicator of addiction in the context of social behaviors.

34. Research also has tested whether the Bergen Social Media Addiction Scale sufficiently discriminates pathological versus non-pathological behaviors. Using four independent samples (N=4,256 participants), results revealed that the items on that scale, which are self-reported by participants, do not permit a unitary measurement that reliably assesses any purported social media addiction. Consistent with prior research that has assessed behavioral addiction scales, the factor assessing tolerance and salience did not show any association with psychiatric symptoms. This strongly suggests that the scale pathologizes engagement in appetitive behaviors and fails to distinguish between non-pathological and pathological behavior (Charlton et al., 2007, Fournier et al., 2023).

35. To demonstrate the tendency to over pathologize normative behaviors and the problematic approach of using current self-report measures probing social media addiction, a recent study developed an Offline-Friendship Addiction Questionnaire (O-FAQ) using reworded items from measures commonly used to classify potential social media addiction. Similar to substance use and social media addiction measures, the O-FAQ assesses both the frequency of the activity and the desire/motivation to pursue the activity (i.e., spending time with friends offline)—which is in line with Griffiths’ components model (Griffiths, 2005). In a large undergraduate student sample (n = 807), 69% were classified as “addicted” to their friends. This study poignantly demonstrates that current social media addiction measures (as well as this offline friendship addiction measure), which have been adapted from models focused on substance misuse, are not appropriate for accurately identifying problematic behaviors. Namely, there is a strong tendency to mischaracterize developmentally normative behaviors (e.g., adolescent pursuit of community and connectedness) by misrepresenting them as pathological (Satchell et al., 2021; see also, Calvo et al., 2018; Flayelle et al., 2019).

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36. To reiterate, there is no widely accepted clinical concept of “social media addiction,” and presently, it is not recognized as a disorder in the DSM-5. The most frequently used tool to assess social media addiction (i.e., Bergen Social Media Addiction Scale) relies on a model that is poorly suited for behavioral addiction, as it was originally developed to explain features in the context of addiction to substances (e.g., alcohol, drugs). The components model pathologizes frequency of use, and rigorous research focused on behaviors (e.g., social media, internet use, online gaming) has demonstrated that frequency of engagement is neither related to psychiatric symptoms nor capable of distinguishing non-pathological and pathological behaviors (Calvo et al., 2018; Charlton et al., 2007; Flayelle et al., 2019; Fournier et al., 2023).

37. In an apparent attempt to support their claims of addiction, Plaintiffs also claim that social media companies manipulate dopamine in adolescents to increase social media use. Plaintiffs characterize dopamine as a drug-like substance that leads to addiction. Master Complaint ¶¶ 68-75. This claim is not founded in science. Dopamine is a naturally occurring and vital brain chemical. It plays a central role in a wide range of key brain functions, including attention, learning, memory, motivation, movement, and reward processing (e.g., appetitive behaviors). For example, dopamine is a chemical messenger that is naturally released (or projected) from the midbrain to different brain regions to facilitate functions including attention (in the prefrontal cortex and reward processing (in the striatum)). When dopamine is projected (i.e., sends messages between nerve cells) to specific brain regions, this facilitates the desired function (e.g., attention, learning, memory) and associated behaviors (e.g., Dunlop et al., 2007, Treadway, 2015). Accordingly, dopamine is vital for everyday functioning, supporting core aspects of adolescents’ lives.

38. Contrary to Plaintiffs’ claims, dopamine release does not equate to addiction. This claim is patently false and a gross misrepresentation of dopamine’s role in the brain. As noted, dopamine is released (i.e., projected) to a wide range of brain regions at any given time to support several disparate functions (e.g., attention, learning, memory; Dunlop et al., 2007, Treadway, 2015), which are critical for the seamless functioning of all individuals. Accordingly, the

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projection of dopamine is not in itself reflective of an addictive tendency, and the release of dopamine, in most circumstances for the vast majority of humans (and animals), does not increase the likelihood that addiction will occur.

39. Furthermore, it is hasty and reckless to draw a link between dopamine and “social media addiction.” The peer-reviewed research does not specifically test any possible relationship between dopamine and social media use. Plaintiffs’ implications of dopaminergic alterations caused by social media use are, therefore, speculative.

2. Scientific evidence does not support Plaintiffs’ claim that social media use causes harmful changes in the adolescent brain.

40. In this section I consider Plaintiffs’ claims that social media use causes negative brain developments in adolescents. Accordingly, I evaluated research that has explored connections between social media and alterations in brain structure or function, and further, whether any such alterations may increase risk for psychiatric disorders and related problems (e.g., addiction, depression, anxiety, self-harm, and suicide). *See supra* ¶¶23-25. As a clinical research scientist who studies the neural and behavioral predictors of depression and suicide, this reflects a substantive component of my daily research focus (e.g., Auerbach et al., 2021; Auerbach et al., 2022).

41. My analysis in this section of the report focuses on whether the existing scientific literature provides a reliable basis to conclude that there is a causal connection between social media use and changes in brain development or function. There are notable challenges that extend across publications, which are elaborated in the reviews. Collectively, the extant research clearly does not support a causal link between social media use and any changes in brain development or function, much less negative ones.

Background on MRI

42. All studies I reviewed for this section used magnetic resonance imaging (MRI) to assess brain function and structure, which is a non-invasive approach (i.e., the participant lays flat in the MRI scanner and no contrast dyes are injected prior to the scan). Both functional (i.e., resting

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and task-based MRI) and structural MRI are commonly used in psychiatric research among adolescents. Functional MRI (fMRI) assesses both resting state fMRI as well as task-based fMRI. The fMRI scans measure blood-oxygen-level-dependent (BOLD) signal (i.e., blood flow) to different regions of the brain. An increased BOLD signal within a given region reflects increased activity. Resting state fMRI measures brain activity with a person's eyes open or closed, and it is believed to reflect the natural state of the brain without any external stimuli (e.g., pictures, task demands). By contrast, task-based fMRI measures BOLD signal while an individual completes a task in the scanner (e.g., a computer game), and it is intended to engage specific regions of the brain (e.g., reward-related functioning, control functioning). Structural MRI measures the volume and shape of brain regions.

43. These methods are frequently used to probe neural markers for psychiatric disorders. Part of the challenge in identifying neural markers of psychiatric disorders in adolescents is related to study design issues (e.g., small sample sizes, non-representative samples, cross-sectional designs; these limitations are elaborated in ¶¶45a-h). The other challenge is that adolescence is a critical developmental period that is characterized by maturation of the brain, particularly in its frontal regions. Foundational research has mapped out typical cortical growth trajectories across childhood and adolescence (see Gogtay et al., 2004). Although this does provide an opportunity to identify potential deficits in brain development, there are many instances in which deviations in cortical growth did not persist, and the differences at a given point in time merely reflect a growth delay (Shaw et al., 2011). This underscores the importance of using longitudinal approaches—including multiple MRI scans—over extended periods of time throughout adolescence, as an alteration in neural functioning or structure at any given time point may merely reflect a temporary growth delay, and accordingly, not a true developmental deficit.

44. As discussed further below, neuroimaging studies related to social media primarily focus on functional activity in specific brain regions, and most of these studies are cross-sectional, which cannot distill causality nor tease apart whether activity patterns are a deficit versus a delay. Most studies used resting state MRI, which, again, observes what the brain is doing at rest without

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any visual stimuli or a task (e.g., completing a game in the MRI scanner). Few studies used tasks in the MRI scanner to interrogate specific behaviors (e.g., cognitive control). A small minority of studies tested associations between social media use and brain structure volume. Most critically, to demonstrate that social media adversely affects brain development, research would need to demonstrate that: (a) social media use has a prospective (not correlational or cross-sectional) impact on a brain activation pattern, and (b) this brain activation pattern also is related to negative outcomes (accounting for known confounders). The research to date does not establish these connections. Therefore, it is my opinion that these studies do not provide evidence of a causal link between social media use and negative adolescent brain development.

Study Limitations.

45. Overall, the current research focused on social media and brain function/structure is characterized by substantial limitations, and statistically significant findings should be interpreted with caution. Specific study design limitations are discussed below; however, the primary challenges that cut across almost all study designs include the following.

a. *Failure to Distinguish Normal Brain Activity from Negative Brain Alterations.*

A few studies show an association between social media use and brain activity. However, this is unsurprising, in that online content, like any content or sensory stimulus, will engage different brain regions. Brain activation is a normal and expected response, occurring following both online and offline experiences—the vast majority of which is not harmful but rather *goal directed*, as different brain regions are activated according to function (e.g., hearing, touching, working memory, planning, and rewarding experiences). It is critical, therefore, to also evaluate whether observed brain activity is associated with some degree of impairment (e.g., psychiatric symptoms). None of the existing research demonstrates that the brain activity studied impacts adolescent functioning (e.g., symptoms, maladaptive behaviors).

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- b. *Sampling.* In the majority of studies, the sample sizes are very small (e.g., <50 participants) and, accordingly, definitive conclusions cannot be drawn. Small sample sizes reduce reliability and reproducibility of neuroimaging findings (Poldrack et al., 2017). That is, findings may be spurious and not replicable.
- c. *Study Design.* Many studies are cross-sectional, meaning brain function and structure as well as social media use are obtained at a single time point. This precludes the ability to identify cause and effect. Meaning, there is no way to ascertain whether social media caused brain changes, or rather, whether specific neural alterations lead people to use social media more frequently.
- d. *Pubertal Effect.* Most research does not account for pubertal changes. Adolescence is a period of substantial brain development in the prefrontal cortex (which engages planning and problem-solving). Thus, analyses should account for developmental differences, across research subjects. As adolescents do not all go through puberty at the same age or the same pace, accounting for age in analyses is not sufficient. Rather, rigorous research in youth must control for the physical advance of puberty, which impacts brain development (Blakemore et al., 2010), using benchmarks such as “Tanner stages” which can determine whether effects observed are robust to pubertal effects among participants. Most of this research did not account for puberty in their analyses.
- e. *Characterizing Psychiatric States.* Brain alterations have been observed in a range of psychiatric disorders, such as anxiety, depression, and substance use. Thus, any brain scan analyses must demonstrate that any brain alterations associated with social media use persist when accounting for the individual’s psychiatric history (e.g., lifetime diagnoses, current symptoms). This is critical because associations observed in these studies may otherwise be accounted for by the presence of the individual’s psychiatric disorders more generally, as opposed to the individual’s social media engagement specifically.

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- f. *Self-Report Assessment of Social Media Use.* Assessment of social media use relies almost exclusively on self-report assessments of participants' own use. Research has shown that youth are largely unable to accurately assess use patterns over extended periods of time, as the tendency is for youth to vastly overestimate their social media use (e.g., Boyle et al., 2022). Moreover, usage patterns may be susceptible to a number of biases (e.g., social desirability, mood-related effects), which compromise the accuracy of self-reported social media use (e.g., Boyle et al., 2022).
- g. *Divergent Independent Variable Measures.* Many studies do not focus specifically on social media use. Rather, the study of social media use is often subsumed within a broader umbrella of behaviors, including internet use, smartphone use, gaming, and streaming videos. Critically, exposures substantially differ across these media. The focus on a broad umbrella of behaviors as a proxy for social media use is deeply problematic given the range of activities this includes, across both passive (e.g., searching the internet, reading news, watching videos) and active (e.g., texting peers/family, posting online) approaches. Given the range of activities, these studies cannot draw any definitive conclusion about the unique and direct impact of social media use—let alone the impact of any specific platform or feature—on the developing adolescent brain.
- h. *Failure to Assess Social Media Behaviors with Objective Measures.* The majority of studies do not obtain objective assessments of social media use. Objective assessments are necessary to better contextualize *what* youth are doing on social media (e.g., scrolling, posting, messaging, etc.). Given the range of potential social media behaviors, such objective assessments are essential, as they may provide more concrete information about social media use and

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potential adolescent behavioral outcomes (e.g., do specific activities on social media result in prosocial behaviors?).

Cross-sectional Neuroimaging Studies.

46. The exemplar cross-sectional studies I discuss in this section relied primarily on task-based fMRI and resting state fMRI. As noted, fMRI studies were generally characterized by small sample sizes, and analyses did not account for other known influences on brain function (e.g., puberty, lifetime history of psychiatric disorders). Studies did not include an objective assessment of social media use; rather, limited self-report measures were utilized, and, in some instances, research relied on a composite score that reflected overall screen media activity (i.e., watching tv/videos, playing video games, using social media) (e.g., Paulus et al., 2019).

47. Some studies report statistically significant associations between social media use and brain activity (e.g., Sherman et al., 2016; Sherman et al., 2018a; da Silva Pinho et al., 2024) in the context of testing “Likes” via an Instagram-based MRI task. This association, however, is neither surprising nor concerning since it merely reflects how the brain responds to gratifying experiences, which is similar and expected as to how the brain would respond to any analogous reward-related stimuli in the MRI scanner (e.g., receipt of food, presentation with engaging images, peer acceptance). One study probed brain activity while participants viewed TikTok videos personalized for the preferences versus general selections. Unsurprisingly, this led to greater default mode network connectivity patterns—again, this is expected, as the default mode network reflects self-referential processing. Thus, it is expected that there would be greater activity (or upregulation) if the video content is more self-relevant (Su et al., 2021)—this is not reflective of aberrant brain activity.

48. Another study among a small sample (N=59) of 18-30-year-old participants from Hungary indicated negative correlations between self-reported social media use and connectivity within the language network (i.e., brain regions critical for producing and understanding language), executive control network (i.e., brain regions implicated in attention, problem-solving, decision-making), and visual network (i.e., brain regions key for recognizing images/objects,

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perceiving motion) (Áfra et al., 2023); though, there are no behavioral data (e.g., impaired language performance, reduced impulse control), which would evidence that this brain activity is problematic. Further, the cross-sectional design precludes any ability to determine causation, as the evidence lacks temporality, as the investigators note, “the *cross-sectional nature of the study limits our ability to discriminate between cause and effect.*” Moreover, many other confounding factors (e.g., psychiatric symptoms or disorders) could potentially explain the relationship.

Longitudinal Neuroimaging Studies.

49. Similar methodological challenges were observed in longitudinal studies reviewed, including but not limited to a failure to account for pubertal development (which has known influences on brain function), lifetime psychiatric history or current symptoms, poor/limited assessment of social media use, and failure to account for psychiatric medication use. Generally, sample sizes were small, which reduces the rigor and reproducibility of findings. Whether in isolation or aggregate, these confounders have profound implications for data interpretability.

50. Again, some studies found statistically significant associations between social media use and brain activity, but those studies have methodological limitations that prevent any causal inference (e.g., He et al., 2023; Kang et al. 2023; Maza et al., 2023). These studies relied on a crude self-reported assessment of social media use (e.g., frequency of checking social media) with a liberal data analytic approach that may be prone to false positives (i.e., showing associations that are significant but only because a greater number of analyses were conducted, which increases the probability of one association being statistically significant). Moreover, the Kang et al. study of college students failed to account for other known likely influences on social media use (e.g., psychiatric symptoms, lifetime diagnoses, the influence of the COVID-19 pandemic in which the study was situated) that are more likely to influence the frequency of social media use (e.g., Steinsbekk et al., 2023). Similarly, in the Maza et al. study, fMRI data were acquired when participants completed a social incentive delay task to interrogate the brain activation during the anticipation of reward, punishment, and neutral feedback. There were no task effects (i.e., differences in patterns of brain activation for reward versus punishment), and therefore, brain

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activation patterns are provided irrespective of the trial type (i.e., reward, punishment). Said differently, results did not differ for trials in which participants were anticipating reward versus punishment feedback (participants were aware that on a given trial whether they were to receive either reward or punishment feedback). This non-significant finding was not expected, and accordingly, makes interpreting results speculative. Further, despite assessments occurring during a peak period of anxiety and depression during adolescence, the study did not attempt to control for the presence of any symptoms or diagnoses. Again, this is a serious methodological flaw because it may be the case that youth experiencing certain symptoms exhibit different brain activations and are also more likely to use social media more frequently (e.g., greater loneliness and sadness may lead to more frequent social media use; e.g., Steinsbekk et al., 2023).

51. Conversely, most longitudinal studies found a non-significant relationship between social media use and brain function (e.g., Achterberg 2022; Flannery et al., 2024; He et al., 2025; Miller et al., 2023).

52. Overall, given the deeply flawed methods employed (e.g., unreliable assessments of social media, failure to assess and account for symptoms/disorders, failure to assess puberty) within extant research (e.g., He et al., 2023; Kang et al., 2023; Maza et al., 2023), coupled with the fact that most studies show non-significant associations, this research does not support a claim that social media use causes clinically significant brain-related changes much less brain changes that would indicate the onset of a psychiatric disorder.

Review Articles Focused on Neuroimaging.

53. Review articles present similar methodological challenges to the individual studies discussed thus far. For example, with respect to Wadsley et al. (2023), 12 of 28 studies included had sample sizes of fewer than 50 participants (i.e., too few participants to obtain a reliable association). Only 4 out of 28 studies—but only 3 of the 28 unique samples—included adolescents with an average age of 18-years-old or younger. Thus, the vast majority of this research was conducted in young adults or adults. This is challenging because: (a) adolescent social media habits likely differ from those of adults and (b) other underlying factors, including preexisting psychiatric

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disorders, may drive adolescent social media use. Said differently, without accounting for potential underlying disorders and symptoms, it is not clear what is contributing to neural alterations (to the extent alterations exist at all). Critically, the vast majority of the research was cross-sectional, as only 3 out of 28 studies included a longitudinal design, and only 2 out of 28 studies completed more than one fMRI recording, which would be needed to potentially establish that persistent social media use changed brain activity.

54. As another example, Marciano et al. 2021 was primarily focused on providing an overview focused on the neural correlates of screen time, smartphone use, and/or internet addiction, as opposed to neural correlates of social media use. As with much of the summarized research, the correlates considered were generally not clinically problematic or concerning on the amounts and contexts considered. Yet, the results are inconclusive given that: (a) nearly every study was cross-sectional, which precludes the ability to disambiguate cause versus effect, (b) studies focused primarily on screen time, smartphone use, and/or internet addiction (i.e., studies did not focus on social media use), and (c) most studies relied on very small sample sizes, which limit the reliability and representativeness of the findings. The scoping review summarized a wide range of significant and non-significant associations (often conflicting across studies). However, the substantial limitations of the largely cross-sectional research included undermine the ability to draw any definitive conclusions about causation regarding social media, particularly inasmuch as studies included did not even assess social media use specifically.

* * *

55. Most of the research focusing on the relationship between social media use and adolescent brain development is not statistically significant. Research showing tentative associations relies on methodologies that are deeply problematic (e.g., small sample sizes, failure to account for known confounders (e.g., puberty), reliance on cross-sectional designs, poor assessments of social media use (e.g., no use of objective assessments, not uncoupling content versus features), and failure to account for other underlying psychiatric diagnoses). Accordingly, I conclude that the existing evidence does not support a conclusion that social media use adversely

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affects adolescent brain development. Moreover, there also is no evidence that brain-related changes resulting from social media use are then associated with negative outcomes (e.g., increased psychiatric symptoms, social support impairment).

B. Scientific Literature Does Not Support A Causal Link Between Social Media Use and Plaintiffs' Alleged Harms

56. Plaintiffs assert that social media use has caused increases in the emergence of psychiatric disorders among adolescents. Master Complaint ¶ 121. However, the empirical evidence does not support this claim.

Evaluating the Evidence

57. In this section, I examine representative research focused on assessing the relationship between social media use and adverse mental health outcomes. Given the focus on causality, cross-sectional articles were deemphasized as these studies cannot disambiguate cause versus effect (i.e., temporality). Rather, studies with longitudinal or experimental designs generally have greater potential to inform causation. Reviews, particularly systematic reviews, provide expert perspectives on extant challenges within the field, with meta-analyses synthesizing results from multiple studies and thus reducing bias and improving reliability of results. Meta-analyses that only consider cross-sectional data, however, are subject to the same limitations as the underlying studies and cannot support a causal inference.

58. As described below in the summaries of each category (i.e., cross-sectional, longitudinal, and experimental studies), there are substantial methodological limitations in the extant research, including the following:

- a. *Failure to Measure Plaintiffs' Alleged Harms as Outcomes.* The research in this space measures a variety of outcomes relating to potential changes in symptoms or mood fluctuations, and not whether social media use leads to the onset of mental health disorders. Accordingly, these studies cannot directly support Plaintiffs' claims that social media causes such mental health disorders.

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- b. *Self-Report Assessments of Social Media Use.* The assessment of social media use in most studies is deeply flawed. Most of the published research utilizes self-report assessments (often single item measures) of screen time or time spent on social media. Screen time includes a broad suite of activities, including social media, gaming, reading, streaming videos, and internet browsing, and thus, it is not an appropriate or reliable proxy for social media engagement. Indeed, even “social media” does not capture a uniform category of activities, which can vary substantially within and across platforms. Moreover, self-reported measurements of time spent on social media are also deeply problematic. It is well established that youth cannot recall with accuracy the time they spent on social media—generally over-estimating the time spent on social media platforms (e.g., Ellis, 2019). This undermines research that relies on these self-reported measurements because if the assessment of time spent on social media is inaccurate, then all subsequent results would also be unreliable. More broadly, this overly simplistic approach fails to capture the complexity and nuance regarding the range in activities adolescents engage in through various social media platforms (e.g., posting, scrolling, direct messaging, watching videos, reading news). The optimal approach would capture objective social media behaviors on particular platforms (i.e., direct measurement of use through the applications), which would clarify how much time was spent on social media as well as delineating activities on the internet (e.g., scrolling, posting, messaging) and exposures to particular types of content. The vast majority of research, however, has continued to rely on self-report approaches that are inaccurate and unreliable.
- c. *Study Designs.* Much of the research in this field relies on cross-sectional designs, which cannot establish causation (i.e., “did social media use cause the symptoms, did the symptoms cause social media use, or did something else cause them both?”). Longitudinal studies that have sought to overcome this limitation have largely not

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established an association among social media and mental health outcomes (e.g., Panayiotou et al, 2023; Steinsbekk et al., 2023). Ultimately, cross-sectional and longitudinal research are problematic because these studies do not readily account for offline experiences but rather focuses on online experiences in isolation. This is a critical problem for this literature because it is well-established that adolescents' offline experiences often mirror online challenges. For example, youth experiencing offline peer victimization are also more likely to have these experiences online (e.g., Kowalski et al., 2014). Importantly, there is ample evidence that youth struggling with mental health concerns (e.g., loneliness, sadness) tend to spend more time engaging with content online (e.g., reviewing peers' feeds and pictures; Underwood et al., 2017) and are more active on social media (e.g., posting, chatting; Puukko et al., 2020).

- d. *Sampling.* The majority of the research on social media use and adolescent mental health suffers from significant sampling problems. Participants in the research generally are not representative of adolescents in the United States. For example, a majority of the research findings rely on college students, often students enrolled in general psychology courses. Among the experimental studies reviewed in this expert report, most studies were conducted on college students (very few of the studies were administered to adolescents specifically—that is, youth 18-years-old and younger). Accordingly, findings based on these population samples are very likely to result in skewed conclusions. These studies are also conducted with convenience samples (i.e., easily accessible participant pools) but not representative samples (i.e., reflecting diverse socioeconomic, race, ethnic, and gender backgrounds), which calls into question the generalizability of the findings, and limits their applicability to adolescents (versus college students; Odgers et al., 2020).

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- e. *Failure to Account for Psychiatric History.* The majority of research, including many of the papers that have observed a correlation between social media use and mental health outcomes, does not account for current or past psychiatric symptoms. When studies account for prior symptoms or disorders as confounders (i.e., variables that may affect the outcome), any relationships found between social media use and the outcomes measured are substantially reduced.
- f. *Weak and Inconsistent Associations.* When statistically significant associations between mental health symptoms and social media use have been observed in the literature, the explanatory power of the association is very weak. For example, in the Twenge et al. (2018) paper that reported an association between adolescent social media use and depressive symptoms, social media accounted for less than 1% of the variance of this association. This means that there were other factors, unaccounted for in the researchers' model, that explain the remaining 99% of the variance. These weak associations are a signature of studies testing the relationship between social media use and mental health outcomes. This is further underscored in meta-analyses of this literature, which generally observe either very weak or null associations (e.g., Valkenburg, 2022).
- g. *Participant Response Bias.* In efforts to test causation, some researchers have utilized experimental manipulations, most commonly through experimental or quasi-experimental studies. Although experimental studies are generally well-positioned to assess cause-and-effect, the existing social media experiments are flawed and unable to support causal conclusions. Specifically, in most studies, participants are randomly assigned to either use social media as they normally would or to modify their social media use. The experimental condition generally involves limiting social media use for a set amount of time (e.g., 30, 60 minutes per day) over a relatively brief period (e.g., 1, 2, 3 weeks). Almost all of this research is based on self-report accounts of participants' frequency of social media use,

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which, as discussed above, is problematic. This issue is further confounded by participants' attempts to self-report their symptoms and/or well-being following the experimental period. Participants are not blinded to their condition (i.e., participants know which condition they are randomized into), and as participants are likely aware of the study hypotheses (i.e., reduced social media improves mental health outcomes), it very likely biases self-reported responses following the experimental manipulation (i.e., self-reports post-experiment). Given the public discourse about the supposed harms of social media and overall time spent online, it is plausible that participants' reports of their reactions to the experiment are influenced by preconceived ideas, as they may have heard (generally repeatedly) that abstinence from social media (or digital platforms more generally) can promote positive mental health outcomes.

- h. *Publication Bias*. In academic publishing, most peer-reviewed publications report on statistically significant results from studies. This means it is very challenging to publish findings from a research study in which there are no significant results. Over time, this can lead to a publication bias, as statistically significant results are published and populate the public health record, while non-significant associations are often discarded in a “file drawer.” This publication bias has led to a recent movement to pre-register studies (i.e., submit a publication outlining study details in advance of collecting any data for the project), and if accepted, journals will publish the results irrespective of whether findings are significant or non-significant. Preregistration provides an opportunity to balance the public health narrative. To date, very few studies focused on social media use and mental health outcomes have been pre-registered. Thus, it is highly plausible that many non-significant findings focused on social media and adolescent mental health remain unpublished and thus unavailable to inform the public health discourse on social media use and adolescent mental health.

CONFIDENTIAL – SUBJECT TO PROTECTIVE ORDER***Cross-sectional Studies.***

59. Broadly, the cross-sectional studies that I considered observed relatively weak associations and were frequently reliant on self-report assessments of social media use (often with a one-item measure of how much time youth spent on social media) (e.g. Kelly et al., 2018; Ozimek, 2020; Lonergan et al., 2019; Vannucci et al., 2019; Wang et al., 2017). More recent research conducted in the United States has found no associations between social media use and depressive symptoms. Specifically, in the Monitoring the Future Study (N=74,742 8th and 10th graders), results show no association between social media and depressive symptoms, and interestingly, among boys, there was a potential protective association (i.e., reduction in negative mental health symptoms) of daily social media use (Kreski et al., 2021).

60. My analysis of these cross-sectional studies is in line with the meta-analyses and umbrella reviews that have summarized the literature on social media use and mental health outcomes after considering the cross-sectional studies that compose a vast majority of the literature. These reviews have generally found that the cross-sectional studies show only “weak” and “inconsistent” associations between social media use and mental health—when associations are present at all (Valkenburg et al., 2022; Hancock et al., 2022). Accordingly, these results do not support any causal conclusion.

Longitudinal Studies.

61. The existing longitudinal studies have also observed mixed findings. Studies reporting statistically significant associations often relied on self-reported assessments of social media use (i.e., one-item measures assessing amount of time spent on social media). Importantly, in studies reporting significant associations, there was limited accounting for known confounders, including lifetime history of psychiatric disorders (e.g., Riehm et al., 2019; Shakya et al., 2017). Of note, although Riehm et al. (2019) reported a significant association, a letter to the editor about this publication highlighted a range of data analytic concerns suggesting that the “patterns [of results] are implausible,” and indeed, when re-estimating models using more stringent data analytic practices, social media use explained only 0.08% of the variance of internalizing and

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externalizing symptoms (see Keyes et al., 2020)—underscoring that other factors overwhelmingly explain the occurrence of these symptoms. Other statistically significant associations were very weak, in that social media use explained 1-4% of variance in depressive symptoms (Nesi et al., 2015; Twenge et al., 2018), strongly suggesting that other unaccounted for factors were likely responsible for the presence of psychiatric symptoms. Put another way, while these studies found weak correlations between social media use and mental health outcomes, there were no indications of any causal connections.

62. A number of studies reporting statistically significant associations included problematic designs. For example, Hökby et al. (2016) reported that internet activities (but not social media explicitly) associated with reduced sleep (but not mental health problems more broadly). Such a finding cannot support the conclusion that social media use, specifically, causes the particular mental health disorders alleged by Plaintiffs. As another example, Coyne and colleagues (2021) found that among 12-15-year-old adolescents (N=500) followed over 10 years, there was an association between social media use and greater suicidal thoughts and behaviors among girls only. At the same time, the study showed nearly identical associations for TV use and playing video games, in part because the measurement was merely “how much time” did youth engage in these activities. The lack of specificity (i.e., same findings across social media, internet, TV use) of these results stems from an unreliable assessment of social media (i.e., 1-item measure probing time spent on social media), which is further compounded by a failure to account for lifetime psychiatric history and the participants’ offline experiences.

63. Other studies reporting statistically significant associations expressly acknowledge that their results do not imply causation (Brunborg et al., 2019; Kandola et al., 2022; Thorisdottir et al., 2020; Maheaux et al., 2024). For example, Thorisdottir and colleagues underscore that “the effect size of these relationships suggest they may not be of clinical relevance” whereas Brunborg and colleagues note that the, “increase in peer relationship problems was a much stronger predictor for change in depression and conduct problems than increase in time spent on social media.” These studies highlight that confounding factors are more likely to drive the occurrence of symptoms

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over time. More broadly, this underscores that failure to account for prior psychiatric disorders in analyses is problematic given that: (a) past symptoms are the strongest predictor of future symptoms (e.g., Garber et al., 2002; Pine et al., 1999) and (b) prior symptoms often increase social media use (e.g., help seeking, find community; e.g., Steinsbekk et al., 2023; Wang et al., 2018).

64. Several studies observed either mixed or bidirectional associations. For example, McNamee et al. (2021) created social media profiles based on self-reported time spent on social media with findings indicating that among youth using social media for 4 or more hours per day, there was evidence of worse mental health symptoms. At the same time, more limited use (i.e., less than 3 hours per day) was associated with more positive peer relationships relative to youth reporting no social media use. Mixed effects also were reported by Frison et al. (2017), as there was a longitudinal association between social media browsing and depressive symptoms but there also was a longitudinal association between depressive symptoms and greater posting over time. Together, these findings underscore the importance of the need to account for confounders—most likely to be prior psychiatric symptoms or disorders—that are likely to better account for the occurrence of symptoms over time. This is particularly true given that there is ample evidence of underlying psychiatric symptoms (e.g., loneliness) that associate with greater social media use over time (Wang et al., 2018).

65. More recent longitudinal research has largely found that there is no relationship between social media use and mental health among adolescents (e.g., Vuorre et al., 2023). For example, Panayiotou and colleagues (2023) found that in 10-15-year-old adolescents (N=12,041) social media use was one of the “least influential factors on adolescent mental health.” Similarly, using more sophisticated analyses (i.e., cross-panel analyses that focus on lagged temporal relationships) intended to determine causal relationships, Steinsbekk and colleagues (2023) found that among adolescents (N=810) assessed at ages 10, 12, 14, and 16, there was no association between social media and mental health symptoms. Indeed, the frequency of social media activities at a given time point (i.e., posting, liking, commenting) was not related to depression or anxiety symptoms two years later. In research focusing on social media use during the COVID-19

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pandemic, results also demonstrated that there was no association between social media use and adolescent well-being (n=1,1415 grades 6 to 9; Charmaraman et al., 2022). Conversely, there was longitudinal evidence among youth who were assessed annually over five years, starting at ages 12-13, that greater depressive symptoms led to more social media use, but the opposite association was non-significant (Puukko et al., 2020).

66. Interestingly, in an 8-year study following youth through adolescence for which assessments were administered annually, there was no relationship between social media use and mental health symptoms over time (Coyne et al., 2020). Similarly, research among adolescents in Australia revealed “no consistent support for a longitudinal association [between social media use and depressive symptoms]” (Houghton et al., 2018) and similarly, among youth from the Netherlands it was found that “neither interactive communication nor passive content consumption demonstrated consistent within-person associations with internalizing difficulties over time” (Tibbs et al., 2025). Collectively, these studies do not support a causal relationship between social media use and psychiatric symptoms, let alone the onset of psychiatric disorders, among adolescents.

Experimental Studies.

67. Experimental studies have sought to clarify whether changing patterns of social media use can impact mental health outcomes. As mentioned above, these experiments almost universally suffer external validity problems because not only did the participants generally know what behaviors and outcomes were being observed (a well-established source of bias in psychological experiments), but they also likely were aware of the experimenters’ hypotheses. At the same time, even without considering these issues of external validity, the extant experiments do not point to any consistent effects of social media abstinence. Many of the studies I reviewed reported results that were non-significant, and a substantial subset showed mixed or non-hypothesized associations often in the opposite direction. Additionally, the vast majority of the research was conducted among university students. Very few were studies specifically focused on adolescents (i.e., adolescents 18-years-old or younger not in college).

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68. *Adolescents.* Relatively few studies focus specifically on adolescents. In a recent study in Hungary with 14-20-year-old youth, participants were randomized into two groups: no phone versus phone as usual for 1-school day. Although anxiety increased for the phone-free students, this finding cannot support any causal conclusion about social media use, particularly as the assessment did not focus on social media but rather one's attachment to their mobile phone (Gajdics et al., 2022). In another study of adolescents, participants were randomized to different conditions regarding how youth were to engage social media (e.g., different approaches to posting). The study found no effects as a result of the experimental condition (Weinstein, 2017).

69. *College Students.* There were mixed associations reported among college students who participated in experimental research. A number of studies reported that reducing use (e.g., time per day over the course of varying number of weeks) was associated with reductions in negative affect, anxiety, loneliness and potential improvements in well-being and self-esteem (e.g., Davis et al., 2024; Faulhaber et al., 2023; Hunt et al., 2023; Kleemans et al., 2018; Sagioglou et al., 2014; Thai et al., 2023). Conversely, many studies showed no association based on the experimental changes (e.g., Collis et al., 2022; Hall et al., 2021; Mahalingham et al., 2023; Przybylski et al., 2021; Tartaglia et al., 2022; van Wezel et al., 2021; Walsh et al., 2023). Studies reporting null associations generally found that abstinence of social media—using various durations—had no impact on mental health (e.g., well-being, loneliness, quality of life). Interestingly, in one study of undergraduate students randomized to the “post more than usual” condition, there was a decrease in loneliness (Deters et al., 2013), suggesting that social media can enhance peer connectedness.

70. Several studies found associations between social media and mental health symptoms. However, these results were not expected or hypothesized, making interpretation difficult, including: (a) passive but not active social media users reported worse symptoms over time (Hunt et al., 2021), (b) groups reported differences in baseline symptoms, which negatively affects our interpretation of post-experiment differences (Thai et al., 2021), (c) only the participants who entered the study reporting more depressive symptoms showed decreased

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symptoms over time, but this association was not applicable to other participants, and there were no associations with other outcomes (e.g., well-being, fear of missing out, anxiety; Hunt et al., 2018), and (d) affect decreased by 20% among undergraduate students in the use social media group but decreased by 24% in the sit quietly and “do nothing” group” (Lepp et al., 2024). Given that these findings were not hypothesized, and include many of the methodological limitations reviewed, these associations should be interpreted with substantial caution.

71. As a whole, findings across college students largely underscore there is no consistent association of social media abstinence with the improvement of mental health outcomes.

72. *Adults.* Experimental research in adults is not likely applicable to adolescents given known differences in how adolescents versus adults engage in social media use (as well as broader developmental differences). Statistically significant associations were reported for improved well-being and symptoms in certain instances (Arceneaux et al., 2024; Brailovskaia et al., 2023; Lambert et al., 2022; Tromholt et al., 2016). Yet, several studies reported mixed results (e.g., Vally et al., 2019; Vanman et al., 2018) or non-significant associations (Brailovskaia et al., 2020).

Review Articles.

73. Broadly, review (i.e., summarizing select methods and/or findings) and consensus articles (i.e., convening of expert panel to address an understudied topic) strongly reinforce the conclusion that the existing literature does not support a causal relationship between social media and youth mental health. These articles reiterate that any observed associations are very weak, which strongly suggests that mental health outcomes are driven by other known confounders (e.g., lifetime history of psychiatric disorders, early life adversity, parenting factors, academic stressors, et cetera).

74. Systematic reviews also almost unanimously highlight the substantial limitations of the extant published research testing relationships between social media use and adolescent mental health. Reviews underscore the reliance on cross-sectional designs (which cannot delineate causation), unreliable assessment of social media use (e.g., one-item measures of time spent on social media), lack of inclusion of known confounders that may drive mental health challenges

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during adolescence, weak effect sizes, and publication biases (i.e., statistically significant results are more likely to be published than null results) (Hancock et al., 2022; Karim et al., 2020; Keles et al., 2020; McCrae et al., 2017; Memon et al., 2018; Odgers et al., 2020; Orben, 2020; Valkenburg et al., 2022; Vidal et al., 2020; Weigle et al., 2024).

75. Several meta-analytic reviews have supported weak associations between social media use and mental health symptoms (e.g., Fassi et al., 2024; Huang, 2017; Ivie et al., 2020; McComb et al., 2023; Yoon et al., 2019). However, these meta-analyses generally agree that weak associations strongly suggest that other factors are driving increases in mental health symptoms (e.g., depression symptoms). In the largest meta-analysis completed, which included 1,094,890 adolescents, Fassi et al. (2024) underscore that although there is a statistically significant correlation between social media use and internalizing symptoms, “no causal inferences can be drawn from the pooled meta-correlation about whether increased social media use leads to higher symptoms or vice versa.” In other words, the meta-analysis cannot solve for the critical temporality limitations of the underlying cross-sectional studies, which preclude causal inferences. Furthermore, even these small associations are not consistently found across meta-analyses. It also is worth noting that one recent meta-analytic review suggested that social media may have positive associations with well-being, particularly for individuals who sought greater connectedness with their peer network (Marciano et al., 2024).

76. Professional consensus reports are similarly skeptical of causal conclusions. A recent American Psychological Association (APA, 2023) report, *Health Advisory on Social Media Use in Adolescence*, stated, “In most cases, the effects of social media are dependent on adolescents’ own personal and psychological characteristics and social circumstances.” This indicates that it is not social media that is *causing* mental health challenges, but rather that there are pre-existing factors that influence both psychiatric outcomes and social media use. At the same time, the APA report also highlighted that social media may *positively impact* adolescent health. This could be the case for a number of reasons: (a) youth psychological development may benefit from online social interaction when aiming to connect with peers experiencing similar health

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conditions, (b) youth experiencing depression or social anxiety may benefit from interactions on social media platforms, as it could afford more control and practice (i.e., learning how to engage same-aged peers), and (c) youth experiencing mental health crises may benefit, particularly in the context of marginalized groups, as they may foster support through communities found on social media (particularly when unable to discuss with a parent or caregiver).

77. Converging conclusions also were reached by the National Academies of Sciences, Engineering, and Medicine in a consensus report focused on social media and adolescent mental health (National Academies of Sciences, Engineering, and Medicine, 2024). The consensus report included insights from leading experts after reviewing current scientific research focused on the question of whether social media use causes mental health problems among adolescents. The consensus report corroborated many of the limitations of extant social media research noted in this expert report (e.g., reliance on cross-sectional designs, poor/unreliable assessments of social media use, failure to account for offline experiences). The consensus report further concluded that the reported associations between social media and adolescent mental health, in most instances, were either weak or non-significant. Accordingly, the experts' conclusion was clear and unequivocal: "The committee's review of the literature...did not support the conclusion that social media causes changes in adolescent [mental] health."

78. In addition, the Lancet Commission (i.e., a scientific review addressing an understudied issue of high public health import) was recently assembled, including leading experts from around the world, to clarify factors influencing self-harm (inclusive of non-suicidal self-injury as well as suicidal thoughts and behaviors; Moran et al, 2024). The consensus report underscores two central issues specific to social media. *First*, the expert consensus report suggests that social media may have a positive effect on youth, particularly those seeking connectedness or community. *Second*, the global experts of the Lancet Commission definitively responded to the claim that the increased uptake of social media may be directly contributing to self-harm behaviors: "the evidence for [that] proposition is uncertain...associations are weak, and do not imply causality." As a whole, these conclusions corroborate my conclusion that there is no clear

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indication that social media use causes self-harm behaviors and, rather, that there may be unaccounted for positive associations with social media in specific situations.

* * *

79. The scientific literature does not exhibit the necessary prerequisites to establish causation. Most of the research focusing on the relationship between social media use and adolescent mental health-related measures is not statistically or clinically significant. If there was a causal relationship, one would expect to observe robust, significant, and consistent associations across studies. This is a critical component to demonstrating a causal conclusion, and it is notably lacking from the research to date. Moreover, much of the research is plagued by significant methodological limitations that undermine the interpretability of even the modest number of studies reporting statistically significant results. These include: (a) reliance on cross-sectional data that cannot establish causation, (b) unreliable assessment of social media use (e.g., reliance on single item measures, use of screen time as a proxy, failure to obtain objective data), (c) failure to account for offline experiences despite substantial data showing comparable experiences, (d) failure to account for known confounders (e.g., psychiatric disorders), (e) use of experimental designs that do not sufficiently mask hypotheses (thus, respondents may be biased to report changes given known expectations), (f) reliance on college student samples that are not representative of the wealth and education levels of the broader United States, and (g) failure to test whether social media use leads to the onset of mental health disorders as opposed to potential changes in symptoms or mood fluctuations. Furthermore, there also may be a publication bias related to statistically significant associations, as these results, despite the weak effect sizes from studies with suboptimal study designs, are more inclined to be published relative to non-significant associations.

80. To summarize, the statistically significant associations that have been reported are remarkably weak (e.g., accounting for 1-4% of the variance) and subject to deep methodological flaws. None of these associations suggest the presence of clinically significant causal effects on

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the development of mental health disorders. Therefore, it is my opinion that the existing evidence does not support the claim that social media causes mental health problems among adolescents.

C. Plaintiffs Do Not Consider Potential Alternative Causal Mechanisms Driving Increased Adolescent Mental Health Struggles.

81. In addition to the methodological limitations considered above, Plaintiffs' presentation of the existing scientific literature also fails to adequately consider other plausible causes of the apparent increase in adolescent mental health disorders at the population level. There are a wide range of social factors that have population-level impacts on mental health. Although I do not believe that any one single factor would be sufficient to explain the totality of American mental health changes in recent decades, Plaintiffs' failure to even consider the range of plausible causes of recent trends significantly undermines their causal claims.

1. Overview of Trends in Adolescent Mental Health

82. Plaintiffs point to current rates of reported psychiatric disorders among adolescents as evidence that social media is causing those disorders; however, this fails to acknowledge that throughout history there have been consistently high rates of psychiatric disorders among adolescents. Indeed, for several decades, epidemiological research has observed high rates of psychiatric disorders among adolescents (Avenevoli et al., 2015; Merikangas et al., 2010). Notably, the National Comorbidity Adolescent Supplement (NCS-A), conducted from 2001-2004, was designed to assess lifetime/current prevalence, age-of-onset, course, and comorbidity of psychiatric disorders among youth ages 13-18-years-old (N=10,123). The NCS-A study predated widespread use of social media use and reveals high levels of psychiatric disorders in the early 2000s. Although older, this study is relevant, as more recent studies are limited in their scope (e.g., Monitoring the Future, National Survey on Drug Use and Health, Youth Risk Behavior Surveillance System) or remain

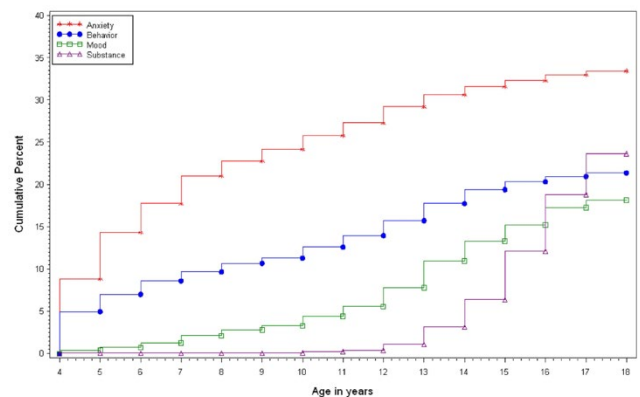


Figure 1. Increase in psychiatric disorders among adolescents from early to late adolescence (Merikangas et al., 2010)

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ongoing but have not assessed the entire adolescent period (e.g., ABCD Study). The NCS-A indicated that among 13-18-year-olds, ~32% experienced anxiety disorders and ~14% percent experienced mood disorders (including depression). Moreover, major depressive disorder (MDD) was found to be increasingly prevalent over the course of adolescence, with rates higher for 17-18-year-olds than for 13-14-year-olds (**Figure 1**).

83. These findings also reflect global trends. In a study conducted through the WHO World Mental Health International College Student surveys, surveys were administered in 19 colleges across eight countries (i.e., Australia, Belgium, Germany, Mexico, Northern-Ireland, South-Africa, Spain, United States). Among the nearly fourteen thousand respondents, 31% screened positive for a disorder in the past 12 months, including 18.5% for major depressive disorder and 16.7% for generalized anxiety disorder. These rates were similar to the lifetime prevalence of those disorders, indicating that adolescence is and has long been a common period for young people to develop these disorders. Moreover, these data collectively show that adolescent-reported disorders often continue into college and beyond, and moreover, prevalence rates are generally consistent across countries around the world (Auerbach et al., 2018).

84. At the same time, it is true that in recent decades the United States has experienced an increase in the prevalence of psychiatric disorders among adolescents. Specifically, there is considerable evidence showing that rates of anxiety (Elia et al., 2023; Tkacz & Brady, 2021) and depression (e.g., Lebrun-Harris et al., 2022; Zablotsky et al., 2022) have increased, particularly following the COVID-19 pandemic (Figas et al., 2023). Similar prevalence rate increases have been observed in eating disorders (Elia et al., 2023; Tkacz & Brady, 2021) and substance use disorders, including alcohol, drug, and tobacco use (e.g., Kann et al., 2018). Rates of suicidal thoughts and behaviors have also increased during this time period (Elia et al., 2023).

85. Plaintiffs' claim that social media has caused this increase in youth mental health problems stems, in part, from the co-occurrence in the adoption of social media and a rise in psychiatric challenges among adolescents beginning around 2010 (see ¶¶121-128 of the Master Complaint). Some have errantly suggested that social media use may be causing the increase in

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youth mental illness despite research evincing weak associations conducted using problematic and unreliable methodologies. *See above* Section IV. Notably, these assertions do not account for several other known contributors that are more directly implicated in the emergence of psychiatric challenges, including: (a) a range of population-level factors (e.g., earlier onset puberty, changes in family structure, the COVID-19 pandemic, and mandated mental health screening), (b) insufficient access to clinical care, (c) proliferation of widespread unpredictable stressors in youth lives endangering stability and safety (e.g., increased school shootings), and (d) persistently high rates of psychiatric illness in caregivers contributing to contagion effects. These factors, either in isolation or combination, have been shown to increase rates of psychiatric disorders among youth. Failure to consider and rule out these factors undermines the reliability of any causal conclusion specific to social media use.

2. Population-level Issues Affecting and Influencing Youth Mental Health.

86. Over the past 15-20 years, many factors have emerged as plausible influences on the increased prevalence in youth mental health disorders in America. For example, there has been a downward trend in pubertal onset among girls (Cheng et al., 2022). Earlier pubertal timing and a more rapid tempo is a key risk factor for girls and is associated with the occurrence of psychiatric disorders (e.g., depression, substance use disorders, eating disorders; Graber, 2013; Marceau et al., 2011; Mendle et al., 2010). Perhaps unsurprisingly, since 2010, it is girls who have shown the largest increases in the prevalence of psychiatric disorders (e.g., Twenge, 2020).

87. Additionally, in recent decades, there has been a continuous decline in two-parent households and married parents (Pew Research Center, 2015, 2023). Among youth living in single parent homes, this is associated with greater stress exposure, susceptibility to experience mental health issues (e.g., depressive symptoms), and economic challenges (during childhood and adulthood; e.g., Daryanani et al., 2016; Lopoo et al., 2014). These are all factors that contribute to the emergence of mental health challenges during childhood and often persist throughout adolescence and adulthood.

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88. The COVID-19 pandemic, beginning in March 2020 in the United States, also had a profound impact on youth mental health. Systematic reviews show deterioration of mental health among children and adolescents, and those with a neurodiverse and chronic physical conditions experienced substantial mental health challenges (e.g., Samji et al., 2022). Longitudinal research among adolescents observed clear increases in depressive symptoms, particularly among youth reporting multiracial backgrounds (Barendse et al., 2023), again a population segment that is showing relatively greater increases in the prevalence of psychiatric disorders. There also were substantial increases in suicidal thoughts, behaviors (e.g., attempts), and deaths (based on trend lines prior to 2020), underscoring the key role the pandemic played in shaping youth mental health outcomes (e.g., Bersia et al., 2022; Bridge et al., 2023).

89. Another factor that likely influenced the apparent change in the prevalence of adolescent mental health disorders was the implementation of the Affordable Care Act, which became a law in March 2010. Under the Affordable Care Act, there was a mandate enacted for mental health screenings. Among youth, mental health screenings typically occur at annual wellness visits within primary pediatric care. Prior to the Affordable Care Act screening mandate, universal screening in pediatric primary was relatively low, which was reflected in the extremely low referral rates for mental health services (1-4%; Kelleher et al., 1997; Kuhlthau et al., 2011). By contrast, in a recent study reporting on data from 2017-2020, 81.48% of youth were screened for depression at their annual physical (Davis et al., 2022). It is highly plausible that these annual screenings have directly contributed to greater reporting of mental health problems that otherwise would have been undetected (see Foulkes et al., 2023, which describes the “prevalence inflation hypothesis” or the tendency for mental health awareness leading to recognition of often under-reported and under-recognized mental health symptoms).

90. Although the Affordable Care Act increased screening for youth mental health issues, it did not solve the problem of persistent mental healthcare shortages in the country, which continue to negatively affect American youth. At present, 45% of the United States population, or 149 million people, reside in a community with a shortage of mental health professionals (Kuehn,

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2022). The challenge is particularly problematic for youth, as there are only 14 child and adolescent psychiatrists per 100,000 youth (which decreased from 15 child and adolescent psychiatrists per 100,000 youth in 2000, reflecting a ~7% reduction in the past 20 years). The scarcity of clinicians has contributed to delays of 6 to 12 months for an initial appointment (Kuehn, 2022). In addition to the scarcity of clinicians and clinical services for youth, a substantial number of practitioners (e.g., social workers, psychologists, psychiatrists) do not accept insurance, requiring families to “pay out of pocket” for expenses. Recent estimates suggest that between 30-50% of providers do not accept insurance (Bishop et al., 2014; Khazan, 2016; Petersen, 2021; Zhu et al., 2024), further accentuating challenges in addressing the mental health needs of youth.

91. Limited availability of mental health care reduces access to those already experiencing psychiatric disorders, and it also hurts youth needing to engage clinical services prior to the onset of disorders to prevent illness progress (e.g., following parental divorce, challenges in school, death of family member/friend). Lack of access to preventative services, in turn, increases the risk of experiencing full blown psychiatric disorders (e.g., Mendelson et al., 2016).

92. Inadequate accessibility to clinical care among adults also may contribute to enhanced transmission of psychiatric disorders from parent to child. In a study of parents and their offspring, the risk for anxiety, depressive, and substance use disorders was three times as high among offspring who have a parent with depression (versus those without a depression history; e.g., Weissman et al., 2006). This phenomenon—the parent-child contagion effect—is well documented, and the transmission of disorders from parent to child is further compounded by reduced availability to psychiatric care among youth. Meaning, for adults who are experiencing psychiatric challenges but not receiving care, there is then greater exposure among offspring, which may increase the risk of contagion and subsequent emergence of psychiatric disorders among youth that are often left unaddressed.

3. Catastrophic Stressful Life Events.

93. It is well understood that stress is one of the most robust triggers of psychiatric disorders (Slavich & Auerbach, 2018). Over the past 15 years, there has been a surge of novel and

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unpredictable life stressors, which have upended childhood in profound ways we do not yet fully understand. Climate-related disasters are now commonplace and deep pessimism about humanity's ability to mitigate the existential threats of climate change is widespread. According to the National Oceanic and Atmospheric Administration (NOAA), there has been a steady increase in the frequency of billion-dollar weather and climate disasters in the United States from ~12 in 2010 to ~23 in 2024 (NOAA, 2024).

94. Similarly, the alarming increase in gun-related incidents in schools (e.g., shootings) has spread fear across the country and left an indelible effect in youth lives, particularly in the face of limited changes to prevent their occurrences. The increased frequency of gun incidents at school (i.e., brandishing a gun, firing a gun, or presence of a gun on school property) and school shootings have left youth feeling that K-12 schools in the United States are not safe. Specifically, since 2010 there has been 1,993% increase in the prevalence of gun-related incidents at K-12 schools,

K-12 School Shooting Database: Incidents by Year 1966-2025

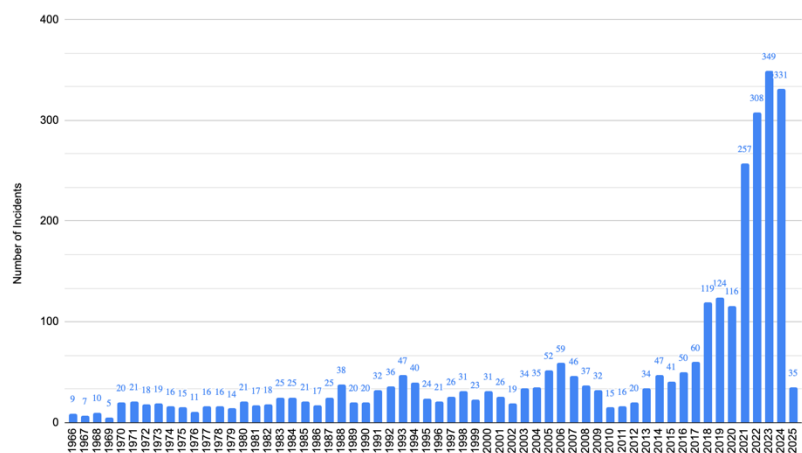


Figure 2. 1,993 % increases in gun related incidents in K-12 from 1966 through 2025 (Statista, 2025).

corresponding with 15 events in 2010 compared to 314 incidents in 2024 (Statista, 2025; **Figure 2**). The mere threat of gun-related incidents, which now occur nearly every day in the United States, destabilizes the school environment. Indeed, it is now commonplace for school children, similar to fire drills, to rehearse active shooter drills to mitigate effects of school shootings (e.g., lock classroom door, avoid windows). Although necessary given the alarming increase in gun-related incidents, the thought of these events unfolding in one's school diminishes safety and fosters a sense of hopelessness. A recent study found that there is some evidence of greater anxiety and stress following active shooter drills (Donovan et al., 2024). Moreover, among those youth

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who experience gun-related incidents at school, there are wide ranging psychiatric consequences (e.g., acute stress, anxiety disorders; Abba-Aji et al., 2024).

95. Collectively, these unpredictable and ever-increasing stressful life events, and the fear and pessimism they engender in society, are destabilizing youths' lives, and accordingly, potentiating risk for the occurrence of psychiatric disorders.

* * *

96. Plaintiffs claim that the co-occurrence of increased social media use and greater adolescent mental health disorder prevalence is itself significant evidence of causation (see ¶¶121-128 of the Master Complaint). As explained above, this is not supported by scientific evidence. Moreover, the adolescent mental health trends Plaintiffs highlight coincide with a wide number of population-level and societal factors that have changed the lives of young people in America, often for the worse. These factors are wide-ranging, suggesting that there is not just one, but likely many, factors influencing the increased prevalence of mental health disorders, plausibly including earlier onset of puberty, changes in family structure, and the COVID-19 pandemic. Since 2010, we also have experienced twice as many climate disasters and a 1,993% increase in the prevalence of gun-related incidents at K-12 schools. These events are stressful in and of themselves, but they have also fueled abstract fears of violence and climate threats across society. Together, the proliferation of unpredictable stress about their safety and future may be an important contributor to adolescent mental health struggles.

**D. Extant Research Has Not Demonstrated That Adolescents' Mental Health is
Negatively Impacted by Specific Features of Social Media, Independent of
Content**

97. For my work in this matter, I have been asked to specifically consider whether the existing science in this area of research addresses possible effects of the design features of social media as opposed to effects to the third-party content that is posted on the platforms.

98. Most research attempting to evaluate the relationship between social media use and mental health does not differentiate between content and features, or between different platforms

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and features. There is, however, a small subset of the research that attempts to address this issue, which I evaluate in this section.

99. Current research focusing on examining the relationship between specific social media features and mental health outcomes is inconclusive. Broadly, social media platforms provide a wide range of features that are intertwined with content. Published research has focused on the impact of these features in isolation, which does not accurately reflect the user experience on social media. This work also has not causally linked any of these specific features to the emergence of psychiatric disorders. The extant research is characterized by substantial limitations.

- a. *Failure to Measure Plaintiffs' Alleged Harms as Outcomes.* As noted above, the research in this space measures a variety of outcomes relating to potential changes in symptoms or mood fluctuations, and not whether specific features of social media lead to the onset of mental health disorders. Accordingly, these studies cannot directly support Plaintiffs' claims that social media features cause such mental health disorders.
- b. *Sampling.* As with many studies investigating the relationship between social media and adolescent mental health, *see supra* Section IV, this literature included a substantial number of empirical articles on college students, with findings that are unlikely to be generalizable to the broader population (especially adolescents).
- c. *Study Designs.* As underscored in a recent systematic review focused on photo-editing and body concerns (McGovern et al., 2022), research focused on testing whether adolescents' mental health is associated with the specific features of social media has often used cross-sectional designs. These designs cannot disentangle cause and effect. Many of the papers reviewed here were cross-sectional, often relying on self-report measures to assess participants' perception of how social features may affect mood and related symptoms (e.g., body dissatisfaction).
- d. *Failure to Account for Confounders.* As noted earlier, most of this research does not consider known confounders that impact outcomes in longitudinal and

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experimental studies. There are a range of factors that influence the likelihood of experiencing symptoms, including but not limited to lifetime psychiatric disorders, pubertal factors, and early life adversity. Models also do not account for offline experiences, which are known to be similar to online experiences (e.g., mood, well-being, body dissatisfaction).

- e. *Specificity at the Cost of Context.* Social media platforms offer a range of content (e.g., photos, gifs, brief videos, new stories) as well as features (e.g., likes, reposts, direct messaging). Experimental studies often focus on a singular feature—often within simulated experimental environments—which are then used to draw sweeping conclusions about a given social media platform. One cannot reliably draw conclusions on how a given feature may impact well-being without considering the whole of the experience on the actual social media platforms.

Cross-sectional Studies.

100. Cross-sectional studies of specific features largely rely on the use of self-reported assessments of feature use (e.g., how often does one manipulate a photo) and then correlate this information with a measure of the participant’s mental health symptoms. The reported statistically significant associations are weak and not necessarily clinically meaningful (e.g., Lonergan et al., 2019; Lonergan et al., 2020; McLean et al., 2015).

101. Several studies focused on the use of an “Instagram-type” task that was administered during an MRI scan. These studies found that receiving “Likes” activated areas of the brain implicated in reward processing. These findings cannot, however, be interpreted as harmful. Rather, this is expected brain activation, which would be consistent with the receipt of any reward in the MRI scanner (e.g., food, exciting images). The studies do not show that the brain activation patterns were associated with negative mental health outcomes (Sherman et al., 2018a, Sherman et al. 2018b; Sherman et al., 2016)

CONFIDENTIAL – SUBJECT TO PROTECTIVE ORDER***Longitudinal Studies.***

102. Few longitudinal studies have been conducted to evaluate specific social media features. Similar to the cross-sectional studies, the one longitudinal study identified for this report relied on self-report assessments of feature use and symptom outcomes. That study found associations between the use of photo filters and greater self-reported body image issues, namely muscle dysmorphia. That said, the study had serious flaws. Its analyses did not account for known confounders (e.g., prior psychiatric disorders, symptoms), and it relied on self-reported data on use of photo filters, which is not likely to be accurate (relative to objective use of photo filters). Thus, the findings are of limited value (Ganson et al., 2024).

Experimental Studies.

103. Most experimental studies on features were conducted with college students only; few included adolescents or adults. Broadly, college students reflect non-representative convenience (i.e., easy to enroll) samples. College student studies tend to focus on how photo manipulation impacted a range of symptoms (e.g., body dissatisfaction). Results were mixed with regards to the consistency of associations, with some studies showing that associations were present in lower facial dissatisfaction but not body dissatisfaction (e.g., Tiggemann et al., 2018, Tiggemann et al., 2019). Other studies suggested associations were more prominent in girls (e.g., Vendemia et al., 2018). Research did not determine whether feature manipulations were associated with clinically significant symptoms, such as anxiety and depression (e.g., Burrow et al., 2016; Mills et al., 2018). A sample conducted in Germany among highly educated individuals, which is not likely to be representative of adolescents in the United States (i.e., older age, restricted to highly educated individuals), also reported associations between negative emotions and receiving fewer “likes” (Voggenreiter et al., 2024). Studies such as these are also problematic inasmuch as the focus on a singular feature is not reflective of one’s holistic experience on a social media platform, which provides access to a range of content and experiences.

104. One study among adolescents suggests that photo manipulation may be related to lower body image (Kleemans et al., 2018), and another study found that receiving fewer “Likes”

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is associated with depressive symptoms (though not clinically significant levels of symptoms; Lee et al., 2020) Here again, there was no accounting for offline experiences as well as current/lifetime symptoms or disorders, undermining the clinical significance of these findings.

105. Overall, the literature does not show that specific social media platform features cause the onset of a mental health disorder. Although some studies have found associations between mood disturbances (i.e., not clinical conditions) and changes in body image, this does not reflect the average user’s experience online (i.e., a focus on the feature at the exclusion of the broader content and experience) and, accordingly, is not reflective of how adolescents interact with social media platforms. It also is important to recognize that of the significant statistical associations reported, none showed evidence of *causing* a psychiatric disorder. This is particularly important given that studies did not account for known confounders, and as discussed, failure to account for these factors undermines the reliability and validity of these findings.

Review Articles.

106. A recent review provided a narrative synthesis of 22 published studies on specific social media features (McGovern et al., 2022). The review primarily focused on the relationship between photo manipulation and body concerns among females. The review concluded that there was “mixed support for a significant association between photo-editing and body concerns.” Interestingly, there is evidence that in specific contexts specific photo manipulations (e.g., skin smoothing, blemish removal) may be associated with more positive emotions as well as a greater likelihood to upload photos. These nuanced findings underscore the non-definitive nature of how photo manipulation may impact socioemotional outcomes for youth.

* * *

107. At present, there are substantial methodological limitations regarding research investigating the relationship between specific social media features and adolescent mental health. Similar to other lines of social media research, limitations include: (a) study designs that are not able to establish causation (e.g., cross-sectional designs), (b) use of self-report assessments to assess how participants engage with features (versus objective use of features in native social

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media platforms), (c) use of non-representative samples (e.g., reliance on college student samples that are convenient but not reflective of the average adolescent), (d) failure to account for offline experiences that otherwise better explain the emergence of psychiatric disorders (e.g., family or academic stressors), (e) failure to account for confounders that are more directly related to adolescent mental health outcomes (e.g., current/past psychiatric symptoms and disorders), and (f) non-generalizable associations inasmuch as features are tested without considering content or context offered on social media platforms (e.g., it is highly implausible for an adolescent to only receive “less likes” on a platform without considering other moderating circumstances, such as direct messages, videos, et cetera). Moreover, the research in this area does not specifically attempt to measure whether the use of social media features leads to the onset of mental health disorders in adolescents but instead focuses on changes in symptoms, or fluctuations in mood.

E. Meta’s Internal Documents Do Not Demonstrate That Social Media Use Results In Addiction, Neurobiological Changes, or Mental Health Disorders Among Adolescents.

108. Throughout the Master Complaint, Plaintiffs allege that Meta’s internal company documents provide evidence to support Plaintiffs’ causal claims. Master Complaint ¶ 193, 272-74, 288. Plaintiffs refer to, for example: (i) slide decks discussing company tools, strategies, ideas, and future directions, (ii) results from surveys to guide product and feature development, and (iii) internal correspondence among employees. Master Complaint ¶ 272-74, 193, 286, respectively. As a clinical researcher, I would not typically consider these types of documents when analyzing a causal question. They were neither peer reviewed nor prepared for that purpose. Nevertheless, given Plaintiffs’ claims regarding these documents, I reviewed exemplar materials. As described further below, my review confirmed that these documents do not provide scientific support for Plaintiffs’ causal claims.

109. I understand from reviewing company materials that Meta conducts user experience surveys to facilitate product development. Kristin Hendrix Deposition Transcript p. 917:4-20; e.g., see [REDACTED] Exhibit 18, [REDACTED] Exhibit 31. To be clear, these surveys are not generally equivalent

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to research-grade studies wherein there is an external institutional review board (IRB) that oversees the risk versus benefits of a given study as well as evaluates the scientific merit of projects. Meta's surveys, which were typically cross-sectional, exhibited many of the limitations noted earlier in this expert report. Specifically, cross-sectional surveys are not able to disentangle cause versus effect because social media use and mental health outcomes (e.g., loneliness, self-esteem, social comparison) are concurrently assessed—*i.e.*, temporality is lacking. Further, most of the surveys used 1-item assessments of constructs (e.g., *Over the last 30 days have you experienced sleep issues?*; e.g., see Hendrix Exhibit 2, p. 8). As is obvious, these data cannot ascertain whether social media *caused* sleep problems. Moreover, none of this research accounts for pre-existing factors that are likely to have contributed to these responses (e.g., current depressive episode or symptoms) nor are these surveys evaluating clinically significant mental health outcomes (e.g., presence of a major depressive episode).

110. In summary, although Plaintiffs assert that Meta has designed its products to cause purported social media addiction among teens, which then causes harm to neural development and mental health, the internal documents, like the broader empirical literature, do not support these claims.

V. Conclusion

111. In sum, I conclude that the existing scientific literature does not support the claims that: (i) social media is “addictive,” and thus negatively affects brain development, (ii) social media causes negative mental health outcomes, and (iii) specific social media features cause mental health problems.

112. To summarize, there is no clinically accepted definition of social media addiction, and it is not a disorder recognized in the DSM-5. Social media addiction models are largely reliant on the components model of addiction (Griffiths, 2005), which was developed to shed light on addictive substances (e.g., alcohol, drugs). Research focused on behavioral addiction has demonstrated that this framework pathologizes normative behaviors, and accordingly, is not a suitable framework to understand whether behaviors (like social media use) are problematic.

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Moreover, recent research testing “social media addiction” scales has demonstrated that measures of “frequency of use” do not show any association with psychiatric symptoms (Fournier et al., 2023), which is in line with similar research showing that these models pathologize normative behaviors (Calvo et al., 2018; Charlton et al., 2007; Flayelle et al., 2019; Fournier et al., 2023).

113. The peer-reviewed literature does not support a claim that social media causes negative brain developments. Although there is limited research investigating the possible impacts of social media use on brain development, most of this research is directed at brain activity in amounts and in contexts that would neither be surprising nor concerning. Even so, most of the studies in this area have not generated statistically significant results. A minority of studies have identified weak associations between social media use and brain activation, but these studies have substantial limitations (e.g., small sample sizes, failure to account for known confounders [e.g., puberty], reliance on cross-sectional designs, poor assessments of social media use, and failure to account for other underlying psychiatric diagnoses), and accordingly, no causal connections can be inferred.

114. The literature also does not support a claim that social media use generally causes negative adolescent mental health outcomes, let alone the mental health disorders alleged by Plaintiffs. While there is an abundance of published findings on this question, they tend to be of very limited value. They generally rely on self-reported accounts of time spent on social media, and on self-reported symptoms of mental health problems, which are unreliable substitutes for actual diagnoses. The literature, as a whole, is also plagued with studies that fail to account for temporality or confounding factors and thus cannot support causal claims. The experimental literature in this area is also flawed, generally failing to mask interventions or hypotheses. Notwithstanding, the field of research shows small and inconsistent associations between social media use and mental health outcomes. This is not what you would expect to find if there was a clinically significant causal relationship, indeed this is inconsistent with the existence of such a relationship.

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115. In summary, it is my expert opinion that Plaintiffs' claim that social media use has caused the increased prevalence of youth mental disorders in the United States is not supported by the scientific literature. Specifically, reliable, scientific evidence does not show that adolescent social media use causes negative outcomes for adolescent brain development or mental health.

A handwritten signature in black ink, appearing to read 'R. P. Auerbach', is written over a horizontal line.

Randy P. Auerbach, Ph.D.

Dated: April 18, 2025